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Assessment of Physico-chemical properties of soil from different blocks of Hamirpur district, Himachal Pradesh, India

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Abstract

The assessment of physical and chemical properties of soil from different blocks of Hamirpur district, Himachal Pradesh, India in 2023-24 was a valuable endeavor. A total of 27 samples were collected at profile depths of 0-15, 15-30, and 30-45. The soil color is light brown. The soil textural class was identified as Sandy Loam, and the sand, silt and clay percentage varied from 71.1% to 62.6%, 19.8% to 15.6%, and 17.6% to 12.8% respectively. Bulk Density was varied from 1.08Mgm⁻³ to 1.28 Mgm⁻³. The Particle Density varied from 2.20 Mg m⁻³ to 2.47 Mg m⁻³. The Pore Space (%) ranged from 49.80% to 40.10%. The Water Retaining Capacity (%) ranged from 46.8 to 37.7%. The pH value ranged from 6.70 to 7.43. The Electrical Conductivity ranged from 0.10 to 0.36 dS m⁻¹. The value of total Organic Carbon (%) varied from 0.45 to 0.27%. The available Nitrogen content of soil ranged from 260.48 to 281.84 kg ha⁻¹. The available Phosphorus content of soil ranged from 18.70 to 10.54 kg ha⁻¹. Available Potassium content of soil ranged from 152.47 to 122.27 kg ha⁻¹. The findings revealed minor increases in bulk and particle density with depth, yet the overall physical condition of the soil seems favourable for plant growth. It is evident that the soils are mostly neutral and meet the acceptable EC limit. The low levels of Organic Carbon are concerning, while Nitrogen levels is low to medium, Phosphorus levels is low and Potassium levels are low. For promoting the soil health and soil quality use of organic manure is recommended for fertilizer application.

Keywords: Soil health, Hamirpur district, physico-chemical properties, texture etc.

1. Introduction

Soil is a dynamic natural body formed by pedogenic processes such as rock weathering and it is made up of mineral and organic ingredients with specific chemical, physical and biological properties. Physical, mineral logical and biological properties that vary in depth over the earth's surface and provide a growing medium for plants. The rate of soil deterioration is influenced by land use patterns, soil types, terrain and climate variables. In appropriate land use is one of these variables that accelerates the deterioration of soil physico-chemical and biological qualities (Bindu *et al.*, 2022) ^[1]. Soil sampling is the most vital step for any soil analysis. It is a dynamic natural body developed as a result of pedogenic processes during weathering of rocks. It's in traditional meaning, is the natural medium for the growth of land plants. Soil consists of minerals and organic constituents, exhibits definite physical, chemical and biological properties of variable depth. Over the surface of earth provides a suitable medium for plant growth. Soil mainly consists of 50% pore space (air and water) and 50% solid phase. The soil phase broadly composed of 45% mineral matter and 5% organic constituents. Soil is all unconsolidated material of the earth's crust in which plants grow, if water and temperature are adequate at least the minimum nutrients are available and toxic substances are in low concentration. Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustain plants, animals, and humans. Creating and maintaining a healthy soil is more than just reducing erosion. The benefits of a healthy soil go far beyond crop production. Improvements in SH via good management can promote crop yields in systems.

Where nutrients or water are limiting via increased nutrient cycling, nutrient availability Foley et al., 2011 [2]. Physico-chemical characteristics of different soils vary in space and time due to variation in topography, climate, physical weathering processes, vegetation cover, microbial activities and several other biotic and abiotic variables. Soil is a dynamic, natural body that occurs on the earth's surface which supports the growth of plants. Soils are formed by the decomposition of rock and organic matter over many years Zaware, 2014 [3].

2. Materials and Methods

Himachal Pradesh is state in the northern part of India. The landmass of Himachal Pradesh stretches to about 55,673 square kilo meters. Situated in the Western Himalayas, it is one of the thirteen mountain states and is characterized by an extreme landscape featuring several peaks and extensive river systems. The district Hamirpur lies at 31° 40' 48" N latitude and 76° 31' 12" E longitude with an average elevation of 790 M (2591.86 ft) above sea level. The average Temperature of Hamirpur is around 17 °C although it vary from around 7 °C during Winter (January) to 25 °C during the Monsoon (June). The hottest month of the year is June with temperature varies from 17.7 °C to 32.4 °C. The coolest month is of the year is January, with temperature varies from 0.2 °C to 15.5 °C. Maximum rainfall occurred in August and minimum rainfall occurred in July. The average annual rainfall is about 1600 mm. It has the humidity about 46.8%. Hamirpur typically receives about 42.86 millimeters (1.69 inches) of precipitation and has 35.54 rainy days (9.74% of the time) annually.

Table 1: Sampling Sites

S. No.	Blocks	Village	Latitude(°N)	Longitude(°E)
1	Hamirpur	Amroh	31°45'04.0"	76°28'18.9"
		ANU	31°41'58.9"	76°31'06.6"
		KUTHERA	31°37'42.6"	76°27'48.4"
2	Naudaun	Balhduhak	31°45'51.0"	76°26'48.0"
		DANGRI	31°44'17.7"	76°22'30.3"
		JEENAH	31°46'42.5"	76°26'37.8"
3	Sujanpur	Ree	31°35'26.9"	76°26'08.2"
		KAROT	32°16'01.2"	75°50'55.9"
		CHABUTRA	31°46'17.3"	76°29'10.5"

2.1 Sampling and Analysis

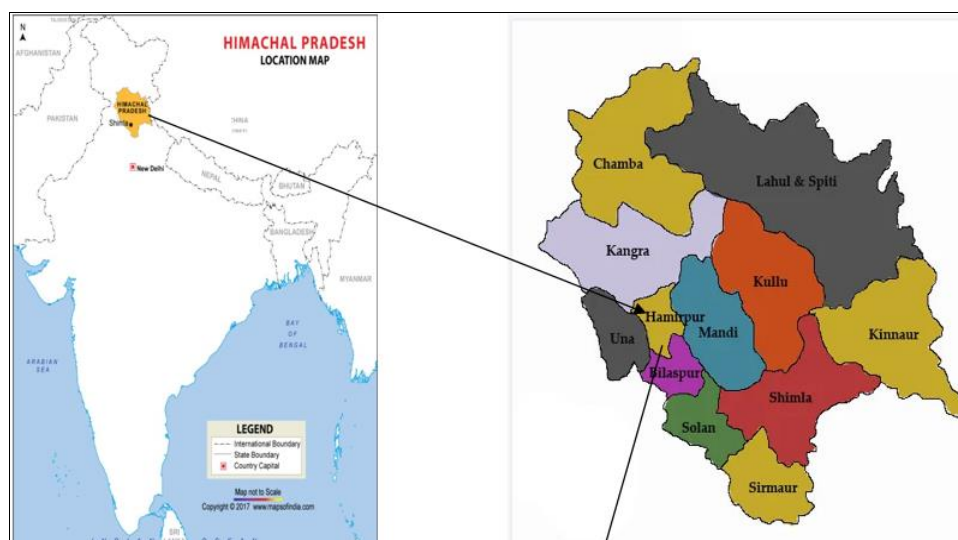
Soil samples from nine villages in three different Blocks of Hamirpur district, Himachal Pradesh were carefully collected and names of these villages along with coordinates shown in table 1. The collection of soil samples involved the use of khurpi, spade, and meter scale. Prior to collecting the samples, the sampling spot was cleared to ensure accurate results. A 'v' shaped cut, 15 cm deep, was made in the sample spot with a spade. In each block, three sampling sites were chosen, with samples taken at depths of 0–15 cm, 15–30 cm, and 30–45 cm. The soil samples collected were thoroughly mixed to ensure homogeneity and to remove any foreign objects like gravel, stones, pebbles, and roots. The mixed samples were then quartered to divide them in half for further analysis of their physico-chemical properties represented in Table 2 and Table 3. The data gathered during the investigation was carefully recorded and later analysed using statistical methods such as Completely Randomized Design (CRD) through the technique of "Analysis of Variance" (ANOVA).

Table 2: Physical analysis of soil

S. No.	Particulars	Scientist (Year)
1	Soil Colour	Albert Henry Munsell, (1971) [4]
2	Soil Texture (sand, silt and clay%)	Bouyoucos, (1927) [5]
3	Bulk density ($Mg\ m^{-3}$)	Muthuvel et al. (1992) [6]
4	Particle density ($Mg\ m^{-3}$)	
5	Pore space (%)	
6	Water retaining capacity (%)	

Table 3: Chemical analysis of soil

S. No.	Particulars	Scientist (Year)
1	Soil pH (1:2.5)	(Jackson, 1958) [7]
2	Electrical conductivity ($ds\ m^{-1}$)	(Wilcox, 1950) [8]
3	Organic carbon (%)	(Walkley and Black, 1947) [9]
4	Available Nitrogen ($kg\ ha^{-1}$)	(Subbiah and Asija, 1956) [10]
5	Available Phosphorus ($kg\ ha^{-1}$)	(Olsen et al., 1954) [11]
6	Available Potassium ($kg\ ha^{-1}$)	(Toth and Prince, 1949) [12]



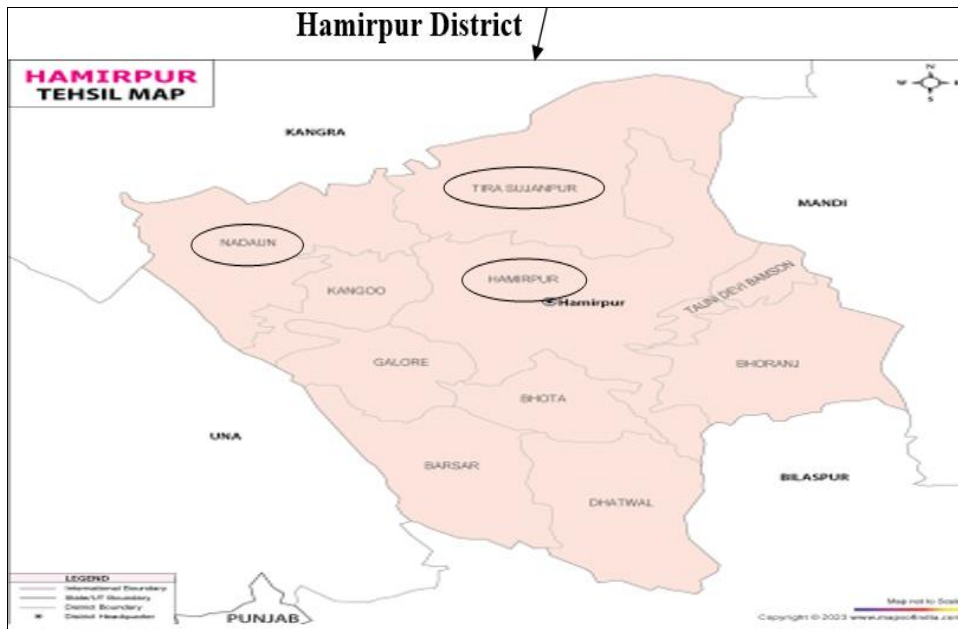


Fig 1: Geographical Map of Study Area

3. Results and Discussion

3.1 Physical Properties

3.1.1 Soil Colour

The findings show that the soil samples collected from Hamirpur, Naudaun and Sujanpur Blocks of Hamirpur district soil colour of samples varies from (10 YR 4/2) Dark grayish brown to (10YR 7/6) yellow. Wet soils appear darker than dry soils. Brown colour is due to contains of relatively large amount of Iron oxide in addition to organic matter. Grey colour of soil is due to water logged condition, with lack of air. Similar outcomes were discovered by Gangopadhyay *et al.*, 2015 [13].

3.1.2 Soil Texture

The soil texture of the Hamirpur district is classified as the sandy loam the sand, silt and clay percentage varied from 71.1% to 62.6%, 19.8% to 15.6%, 17.6% to 12.8% respectively and illustrated in Fig. 2. Similar outcomes were discovered by Mishra *et al.*, (2014) [14] and Digal *et al.*, 2018 [15].

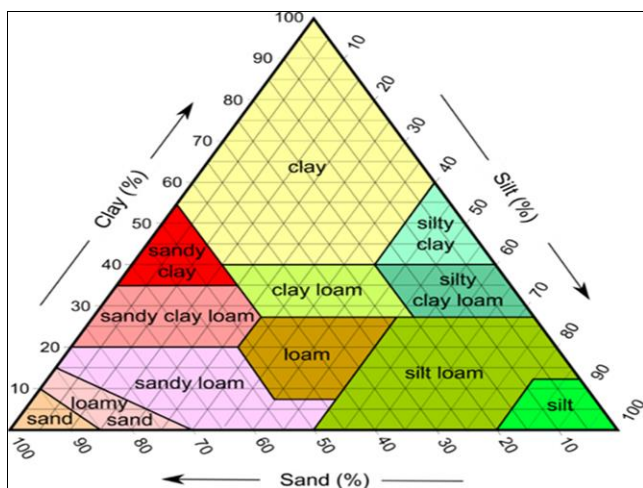


Fig 2: Soil Textural Triangle (Sand, Silt and Clay%) by USDA

3.1.3 Bulk Density ($Mg\ m^{-3}$)

As the result illustrates that the bulk density of soil was varied from $1.08\ Mg\ m^{-3}$ to $1.37\ Mg\ m^{-3}$. The maximum bulk density ($1.37\ Mg\ m^{-3}$) was found in Chabutra village of Sujanpur Blocks and minimum ($1.08\ Mg\ m^{-3}$) was found in Anu village of Hamirpur Block and is represented in Table 4 and is shown in Fig. 3. Similar outcomes were discovered by Yadav *et al.*, 2022 [16].

3.1.4 Particle Density ($Mg\ m^{-3}$)

As the result illustrates that the particle density varied from $2.47\ Mg\ m^{-3}$ to $2.20\ Mg\ m^{-3}$. The highest particle density ($2.47\ Mg\ m^{-3}$) was found in Kuthera village of Hamirpur Blocks and lowest ($2.20\ Mg\ m^{-3}$) was found in Ree village of Sujanpur Block and is represented in Table 4 and is shown in Fig. 3. Similar outcomes were discovered by Yadav *et al.*, 2022 [16].

3.1.5 Pore Space (%)

As the result illustrates that the Pore Space (%) of soil ranged from 49.80% to 40.10%. The highest percentage of pore space (49.80%) was found in Anu village of Hamirpur Blocks and lowest (40.10%) was found in Balhduhak village of Nadaun Blocks and is represented in Table 4 and is shown in Fig. 4. Similar outcomes were discovered by Sangwan *et al.*, 2020 [17].

3.1.6 Water Retaining Capacity (%)

As the result illustrates that the Water Retaining Capacity (%) of soil samples ranged from 46.8% to 37.7%. The highest percentage of Water Retaining Capacity (46.8%) was found in Anu village of Hamirpur Blocks and lowest (37.7%) was found in Chabutra village of Sujanpur Blocks and is represented in Table 4 and is shown in Fig. 4. Similar outcomes were discovered by Sangwan *et al.*, 2020 [17].

Table 4: Bulk density ($Mg\ m^{-3}$), Particle density ($Mg\ m^{-3}$) Pore space (%) and Water Retaining Capacity (%) of soil at various villages of different blocks of Hamirpur district

Blocks	Village	Bulk Density ($Mg\ m^{-3}$)			Particle Density ($Mg\ m^{-3}$)			Pore Space (%)			Water Retaining Capacity (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Hamirpur	Amroh	1.13	1.16	1.18	2.22	2.23	2.24	46.10	45.10	44.20	44.1	43.1	42.1
	Anu	1.08	1.10	1.12	2.21	2.23	2.25	49.80	48.10	46.20	46.8	45.2	44.6
	Kuthera	1.14	1.16	1.19	2.20	2.24	2.27	41.80	41.30	40.80	43.8	42.5	41.2
Naudaun	Balhduhak	1.18	1.20	1.23	2.29	2.33	2.37	42.50	41.60	40.10	47.5	44.9	42.7
	Dangri	1.19	1.22	1.26	2.31	2.35	2.38	46.70	44.40	43.90	47.3	45.1	43.4
	Jeenah	1.23	1.28	1.30	2.30	2.34	2.39	45.40	44.10	42.20	45.7	44.1	42.6
Sujanpur	Ree	1.24	1.27	1.29	2.40	2.44	2.47	48.90	47.90	46.50	46.2	44.9	43.5
	Karot	1.26	1.29	1.32	2.39	2.42	2.46	45.77	44.80	43.20	40.4	39.8	38.5
	Chabutra	1.30	1.34	1.37	2.35	2.39	2.44	47.60	44.80	43.50	39.8	38.4	37.7
F-test		S	S	S	S	S	S	S	S	S	S	S	S
S.Em.±		0.018	0.014	0.014	0.034	0.042	0.022	0.823	0.797	0.512	0.819	0.713	0.671
C.D@5%		0.054	0.042	0.044	0.102	0.124	0.065	2.445	2.370	1.522	2.436	2.121	1.994

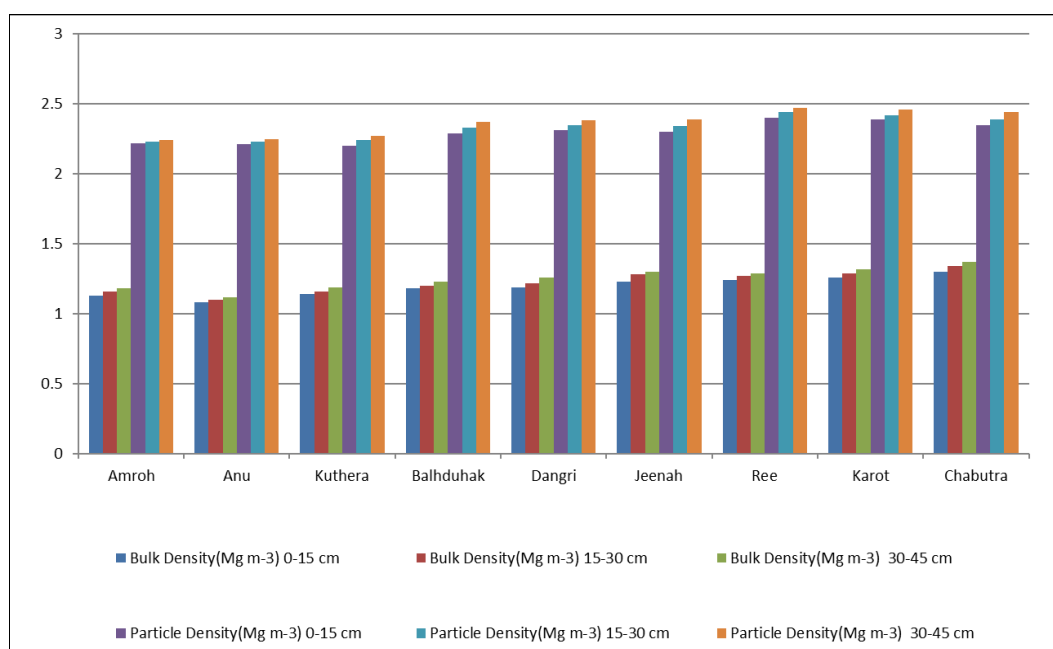


Fig 3: Bulk density and Particle density ($Mg\ m^{-3}$) of soil at various villages of different blocks of Hamirpur district

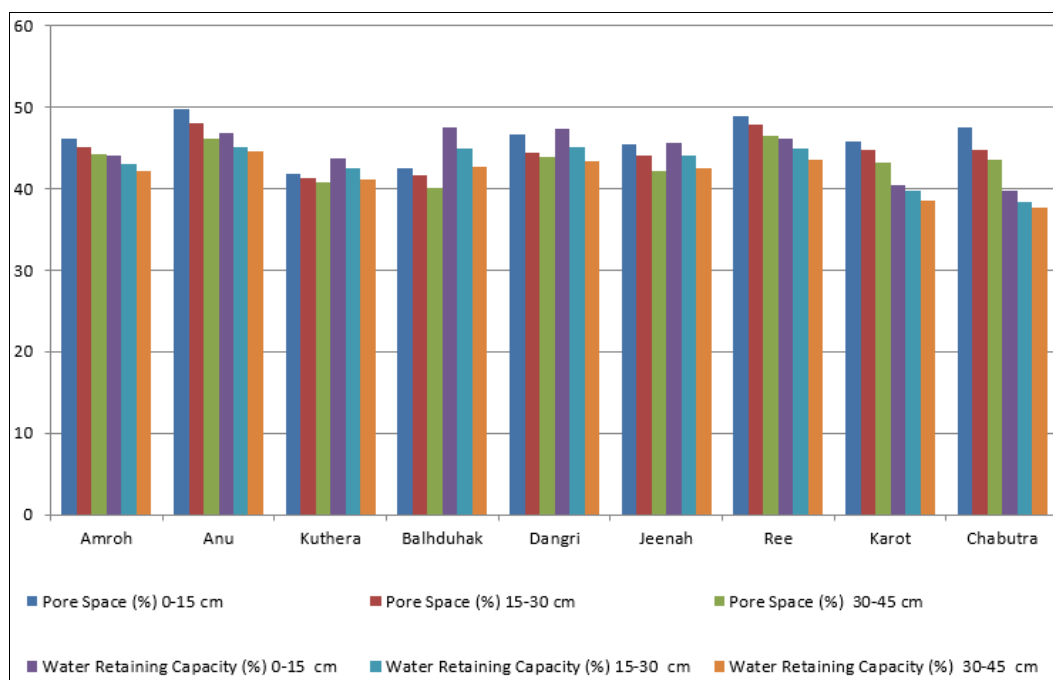


Fig 4: Pore space and Water retaining capacity (%) of soil at various villages of different blocks of Hamirpur district

3.2 Chemical properties

3.2.1 Soil pH

As the result illustrates that the pH of soil ranged from 6.70 to 7.43. The highest pH (7.43) was found in Amroh village of Hamirpur Block and lowest (6.70) was found in Jeenah village of Naudaun Block and is represented in Table 5 and is shown in Fig. 5. Similar outcomes were discovered by Sharma and Dogra 2011^[18].

3.2.2 Electrical Conductivity of soil water suspension (dS m⁻¹)

As the result illustrates that the Electrical Conductivity of soil ranged from 0.36 to 0.10 dS m⁻¹. The highest electrical conductivity (0.36 dS m⁻¹) was found in Jeenah village of Naudaun Blocks and lowest (0.10 dS m⁻¹) was found in Kuthera village of Hamirpur Blocks and is represented in Table 5 and is shown in Fig. 6. Similar outcomes were discovered by Newaj *et al.*, 2007^[19].

3.2.3 Organic Carbon (%)

As the result illustrates that the Organic Carbon (%) of soil varied from 0.27 to 0.45%. The highest percentage of organic carbon (0.45%) was found in Chabutra village of Sujanpur Blocks and lowest (0.27%) was found in Jeenah village of Naudaun Block and is represented in Table 5 and is shown in Fig. 6. Similar outcomes were discovered by Sharma and Dogra

2011^[18].

3.2.4 Available Nitrogen (kg ha⁻¹)

As the result illustrates that the available Nitrogen of soil samples varied from 281.84 to 260.48 kg ha⁻¹. The highest nitrogen content (281.84 kg ha⁻¹) was found in Chabutra village of Sujanpur Blocks and lowest (260.48 kg ha⁻¹) was found in Kuthera village of Hamirpur Blocks. Similar outcomes were discovered by Ali *et al.*, 2012^[20].

3.2.5 Available Phosphorus (kg ha⁻¹)

As the result illustrates that the available Phosphorus of soil varied from 18.70 to 10.54 kg ha⁻¹. The highest Phosphorus content (18.70 kg ha⁻¹) was found in Ree village of village of Sujanpur Blocks and lowest (10.54 kg ha⁻¹) was found in Anu village of Hamirpur Blocks. Similar outcomes were discovered by Hebbara 2014^[21].

3.2.6 Available Potassium (kg ha⁻¹)

As the result illustrates that the available Potassium of soil varied from 152.47 to 122.27 kg ha⁻¹. The Potassium content was observed as medium to high. The highest Potassium content (152.47 kg ha⁻¹) was found in Anu village of Hamirpur Blocks and lowest (122.27 kg ha⁻¹) was found in Jeenah village of Naudaun Blocks. Similar outcomes were discovered by Singh *et al.*, (2011)^[22].

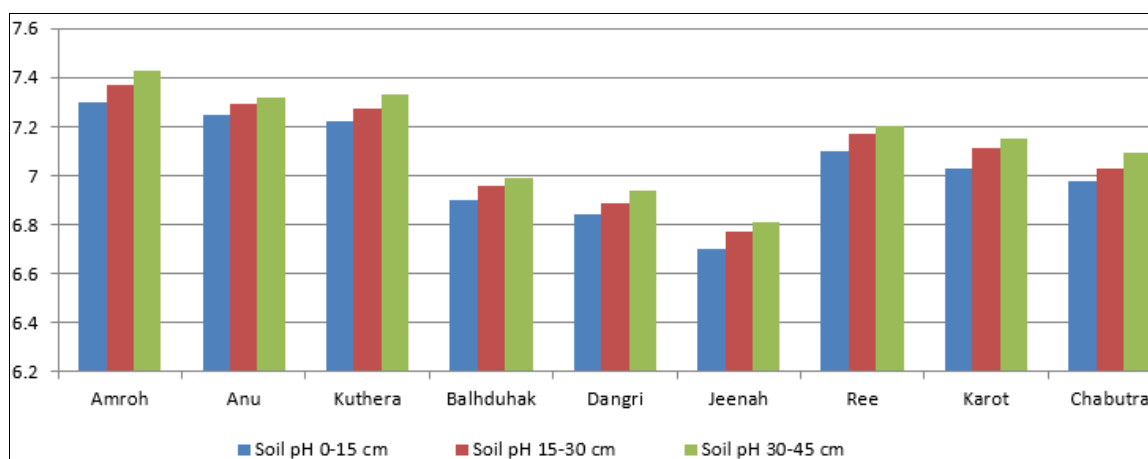


Fig 6: Soil pH at various villages of different blocks of Hamirpur district

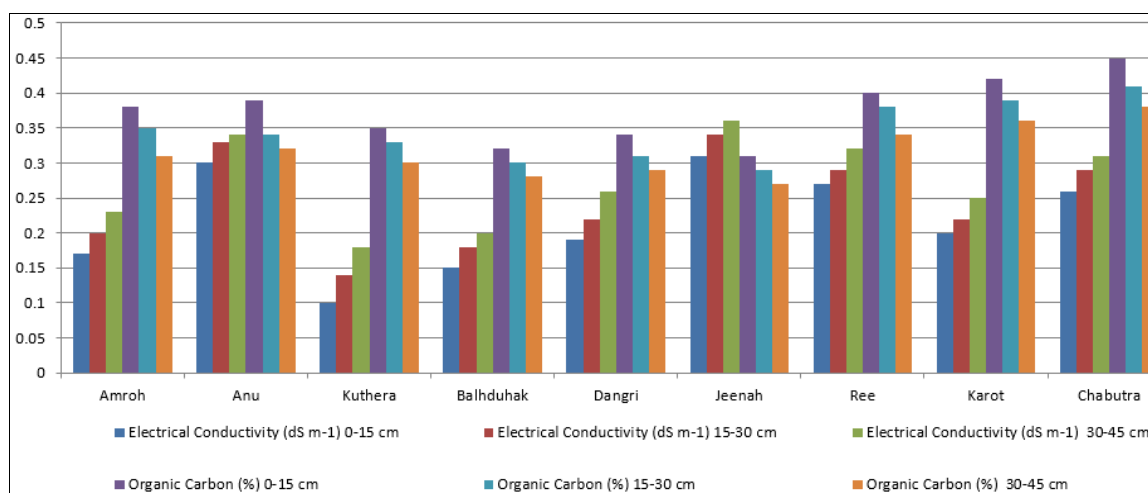


Fig 7: Electrical conductivity (dS m⁻¹) and Organic carbon (%) at various villages of different blocks of Hamirpur district

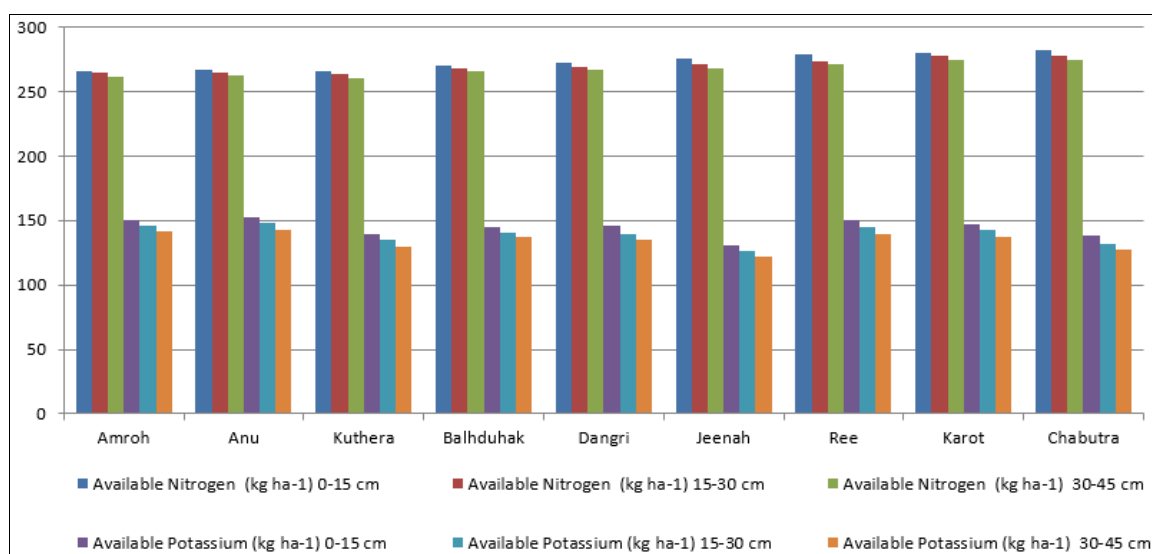


Fig 8: Available Nitrogen and Available Potassium (kg ha^{-1}) at various villages of different blocks of Hamirpur district

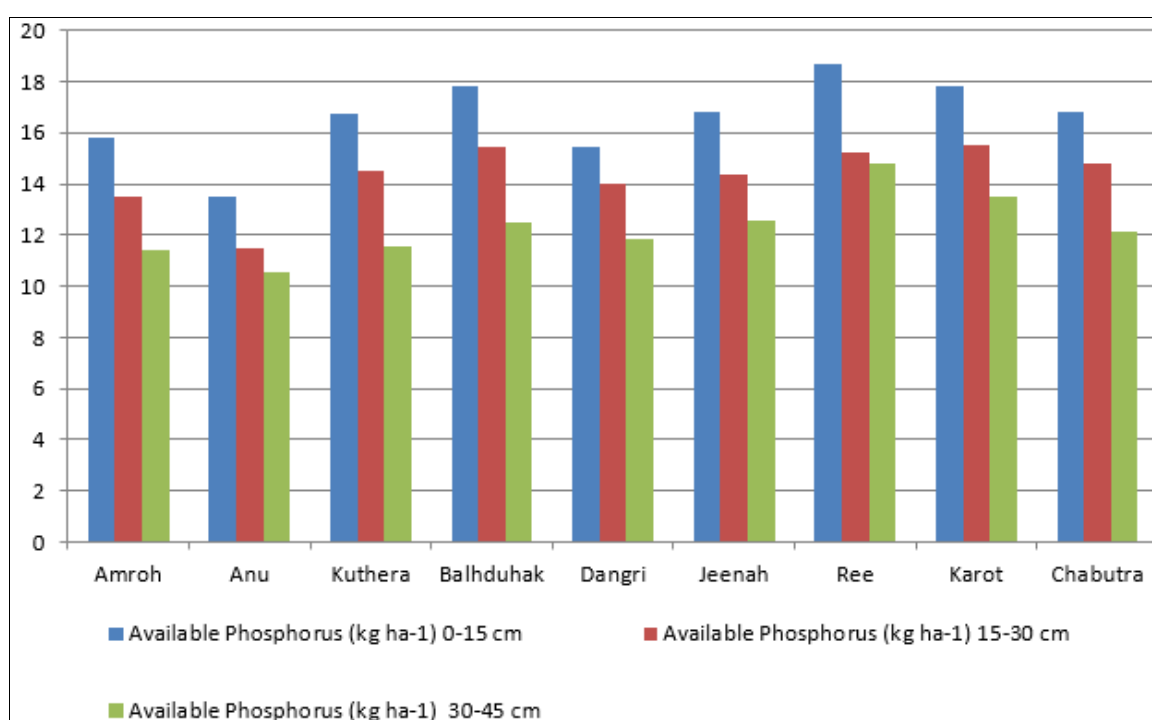


Fig 9: Available Phosphorus (kg ha^{-1}) at various villages of different blocks of Hamirpur district

Table 5: Soil pH, Electrical Conductivity of soil water suspension (dS m^{-1}) and Organic Carbon (%) of soil at various villages of different blocks of Hamirpur district

Blocks	Village	pH			Electrical Conductivity of soil water suspension (dS m^{-1})			Organic Carbon (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Hamirpur	Amroh	7.30	7.37	7.43	0.17	0.20	0.23	0.38	0.35	0.31
	Anu	7.25	7.29	7.32	0.30	0.33	0.34	0.39	0.34	0.32
	Kuthera	7.22	7.27	7.33	0.10	0.14	0.18	0.35	0.33	0.30
Naudaun	Balhduhak	6.90	6.96	6.99	0.15	0.18	0.20	0.32	0.30	0.28
	Dangri	6.84	6.89	6.94	0.19	0.22	0.26	0.34	0.31	0.29
	Jeenah	6.70	6.77	6.81	0.31	0.34	0.36	0.31	0.29	0.27
Sujuanpur	Ree	7.10	7.17	7.20	0.27	0.29	0.32	0.40	0.38	0.34
	Karot	7.03	7.11	7.15	0.20	0.22	0.25	0.42	0.39	0.36
	Chabutra	6.98	7.03	7.09	0.26	0.29	0.31	0.45	0.41	0.38
F-test		S	S	S	S	S	S	S	S	S
S.Em. \pm		0.078	0.071	0.101	0.005	0.009	0.002	0.020	0.016	0.010
C.D@5%		0.232	0.211	0.300	0.001	0.002	0.007	0.060	0.049	0.031

Table 6: Available Nitrogen, Available Phosphorus and Available Potassium (kg ha⁻¹) at various villages of different blocks of Hamirpur district

Blocks	Village	Available Nitrogen (kg ha ⁻¹)			Available Phosphorus (kg ha ⁻¹)			Available Potassium (kg ha ⁻¹)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Hamirpur	Amroh	266.25	264.78	261.15	15.84	13.50	11.42	150.38	145.81	141.55
	Anu	267.48	264.87	262.34	13.54	11.47	10.54	152.47	148.12	142.43
	Kuthera	265.48	263.84	260.48	16.74	14.51	11.54	139.48	134.71	129.84
Naudaun	Balhduhak	270.58	268.49	265.48	17.85	15.48	12.48	144.58	140.28	137.61
	Dangri	272.91	269.45	266.81	15.48	13.99	11.87	145.97	139.47	135.48
	Jeenah	275.81	271.54	268.48	16.80	14.37	12.55	131.18	126.48	122.27
Sujanpur	Ree	279.57	274.15	271.85	18.70	15.20	14.81	149.87	144.50	139.72
	Karot	280.45	277.48	274.81	17.80	15.49	13.50	147.51	142.90	137.82
	Chabutra	281.84	278.15	275.19	16.84	14.80	12.10	138.19	132.29	127.91
F-test	S	S	S	S	S	S	S	S	S	S
S.Em.±	2.39	3.38	2.37	0.607	0.452	0.366	4.357	2.902	3.466	
C.D@5%	7.11	10.07	7.06	1.804	1.343	1.087	12.948	8.622	10.298	

4. Conclusion

On the basis of above finding it is concluded that soil texture is Sandy Loam. The colour of the soil varies from Dark greyish brown to yellow. The physical properties of both surficial and sub-surficial soils are normal as the bulk density value is optimum. The Water Retaining Capacity is medium. The organic content in the soil is medium, nitrogen and potassium is fall under medium range while the phosphorus is low in range. The mainly soil is neutral to slightly alkaline and contains rocks in some areas. Hence, green manure application and usage of tillage practices is advised.

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